PATENT ABSTRACTS OF JAPAN

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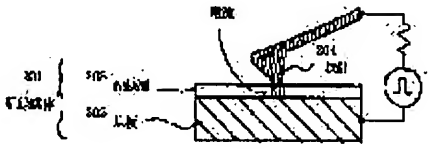
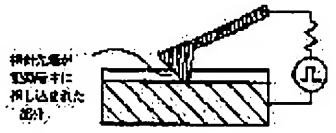
(54) DEVICE AND METHOD FOR PROCESSING INFORMATION

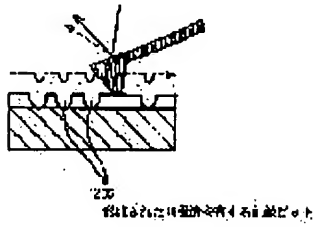
(57)Abstract:

PURPOSE: To facilitate operation, to make the whole device compact and to make possible integration by bringing a tip of a needle into contact with a recording layer, softening the recording layer surface with the heat caused by voltage application and forming a recording bit of a recessed structure.

CONSTITUTION: A recording medium 201 is constituted so as to provide the recording layer 203 on a substrate 202 having conductivity, and material softening by a temp. rise, e.g. thermoplastic resin of a softening temp. of 100°C is used as the recording layer 203. Conductive material having a melting point of 1000°C or above, e.g. metal/semiconductor material is used as the probe needle 204, the substrate 202. Then, the probe needle 204 tip is brought into contact with the recording layer 203 surface, and a recording pulse voltage is applied, and a current is made to flow between the probe 204 and the substrate 203. The temp. of the recording layer 203 is raised partially by the heat caused by the current to be softened. Succeedingly, the needle tip is pushed into the recording layer by repulsive force acting between with the recording layer to form the recording bit 205 having the recessed structure.







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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] In the information processor which scans the probe supported with the elastic body to the record medium which counters this, and processes information by detecting the signal produced from the physical development The record medium softened in the temperature rise of the heat generated according to the current which flows between said probes and said record media by electrical-potential-difference impression of the electrical-potential-difference impression means of a between [said probes and said record media], and this electrical-potential-difference impression means, The information processor characterized by having the record bit means forming which the force which pushes in the tip of the probe supported with said elastic body to the this softened record medium is made to act, and forms the record bit of concave structure in this record-medium front face.
[Claim 2] The information processor according to claim 1 characterized by establishing current-limiting electric resistance into the electrical circuit loop formation which consists of said probe and said record medium, and said electrical-potential-difference impression means.
[Claim 3] Said current-limiting electric resistance is a value with the larger value than the 1st threshold of the electric resistance which restricts a current to the 1st current threshold corresponding to the threshold in which either of said probes and said record media carries out thermal destruction with the heat generated according to the current which flows between said probes and said record media by said electrical-potential-difference impression. And the information processor according to claim 2 characterized by being chosen from the range of a value smaller than the 2nd threshold of the electric resistance which restricts a current to the 2nd current threshold corresponding to the threshold which said record medium softens with said heat.
[Claim 4] Said record bit means forming as force which pushes in the tip of the probe supported with the elastic body to the record medium The repulsive force which acts between this probe and this record medium, Or claim 1 characterized by being constituted so that concave structure may be formed in this record-medium front face using the electrostatic force which adds to this repulsive force and acts between this probe and this record medium by electrical-potential-difference impression - claim 3 are not, but it is an information processor given in ** 1 term.
[Claim 5] Claim 1 characterized by having the signal-processing means for the information playback which detects the record bit of the concave structure formed on said record medium from the elastic deformation detecting signal outputted from a means to detect the elastic deformation of said elastic body, and this elastic deformation detection means - claim 4 are not, but said information processor is an information processor given in ** 1 term.
[Claim 6] Claim 1 characterized by to have a signal-processing means for the information playback which detects the record bit of the concave structure formed on said record medium from the current detecting signal outputted from a current detection means detect the current which flows between said probes and said record media by electrical-potential-difference impression of said electrical-potential-difference impression means, and this current detection means - claim 4 are not, but said information processor is an information processor given in ** 1 term.

[Claim 7] Claim 1 characterized by to have a record bit elimination means eliminate the record bit of said concave structure - claim 6 are not, but said information processor is an information processor given in ** 1 term by making it move in the direction which leaves the tip and said record medium of said probe to said record medium softened with the heat generated according to the current which flows between said probes and said record media by electrical-potential-difference impression of said electrical-potential-difference impression means.
[Claim 8] Claim 1 characterized by having - ****** means of the record bit which the temperature of this whole record medium is raised with a heating means to raise the temperature of said record medium, and eliminates the record bit of said concave structure in package - claim 6 are not, but said information processor is an information processor given in ** 1 term.
[Claim 9] Claim 1 characterized by having the alternative elimination means of the record bit which the temperature of this exposure part on said record medium is alternatively raised by the beam exposure of the source of a beam, and eliminates the record bit of said concave structure alternatively - claim 6 are not, but said information processor is an information processor given in ** 1 term.
[Claim 10] In the information processing approach of scanning a probe to the record medium which counters this, and processing information by detecting the signal produced from the physical development As opposed to the record medium softened in the temperature rise of the heat generated according to the current which flows among them by impression of the electrical potential difference of a between [said probes and said record media] The information processing approach characterized by making the force which pushes in the tip of the probe supported with the elastic body act, and forming the record bit of concave structure in this record-medium front face.
[Claim 11] The information processing approach according to claim 10 characterized by restricting the current which flows between said probes and said record media in impression of said electrical potential difference, and preventing thermal destruction of said account probe and said record medium.
[Claim 12] Formation of the record bit of said concave structure contacts the tip of the probe supported with said elastic body to extent to which repulsive force acts on said record-medium front face. According to this repulsive force Or by adding the electrostatic force which acts between this probe and this record medium by electrical-potential-difference impression to this repulsive force The information processing approach according to claim 11 or 12 characterized by making it act so that the tip of the probe supported with said elastic body to this record medium may be pushed in, and forming a record bit.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] This invention applies the configuration of a scanning PUROPU microscope, and relates to the information processor and approach of performing informational record, playback, and elimination.
[0002]
[Description of the Prior Art] In recent years, the scanning tunneling microscope (it omits Following STM) which can observe a conductive matter front face with the resolution below NANOMETORU which is indicated by the U.S. Pat. No. 4343993 specification is developed, and observation of the atomic arrangement on a metal and the front face of a semi-conductor, the orientation of an organic molecule, etc. is made on the atom and the molecule scale. Moreover, the STM technique was developed and the atomic force microscope (it omits Following AFM) observable with the same resolution as STM was also developed in front faces, such as an insulating material, (U.S. Pat. No. 4724318 specification). The proposal of realizing high density memory is made by applying the principle of this STM, accessing a probe at a record medium, impressing an electrical potential difference in between, and performing record playback of the bit size of an atom and a molecule scale, carrying out feedback control of the record-medium-probe spacing so that tunnel current may be made regularity with an STM configuration, (a U.S. Pat. No. 4575822 specification, JP,63-161552,A, JP,63-161553,A). Moreover, it records by impressing an electrical potential difference in between using the equipment configuration which combined STM and AFM, where a probe is contacted to a record medium. Deformation of the record regenerative apparatus reproduced by detecting a record bit configuration using the principle of AFM, the record regenerative apparatus which applies the principle of AFM and performs probe position control under record and playback, and the elastic body which supports a probe is used. The proposal of a record regenerative apparatus from which a record-medium front face is made to learn is also made in the probe tip during record and playback (JP,1-245445,A, JP,4-321955,A). As one of the recording methods of the high density memory using the above STM or the principle of AFM To a transparent record medium, contact an AFM probe and a probe tip is heated recently by irradiating light near an AFM probe tip from a record-medium rear face. Raise the record-medium temperature of a contact part, make it soft, and the record bit of concave structure is formed according to the force committed between AFM probes. The record playback approach of reproducing by detecting this using the principle of AFM was shown (others [Mamin] Appl.Phys.Lett.vol.61(1992) pp.1003).
[0003]
[Problem(s) to be Solved by the Invention] However, the probe tip was heated by the above optical exposures, and there were the following problems by the approach of forming a record bit in a contact part. Like optical disk memory, since it becomes the configuration which irradiates light at a record part, optics, such as the light source, a mirror, and a lens, are required, the configuration of the whole equipment becomes large, and the problem of being hard to carry out integration is mentioned [1st]. It is necessary to irradiate a focusing light beam in the location at the tip of an AFM probe for record, and

the problem that the alignment of an AFM probe and a light beam is complicated is mentioned to the 2nd apart from AFM signal detection.
[0004] Then, this invention solves the above-mentioned problem, and actuation is easy, the whole equipment configuration is compact, and it aims at offering the information processor which can be integrated, and the information processing approach.
[0005]
[Means for Solving the Problem] In order that this invention may attain the above-mentioned purpose In the information processor which scans the probe supported with the elastic body to the record medium which counters this, and processes information by detecting the signal produced from the physical development The record medium softened in the temperature rise of the heat generated according to the current which flows between said probes and said record media by electrical-potential-difference impression of the electrical-potential-difference impression means of a between [said probes and said record media], and this electrical-potential-difference impression means, By the record bit means forming which the force which pushes in the tip of the probe supported with said elastic body to the this softened record medium is made to act, and forms the record bit of concave structure in this record-medium front face, actuation is easy. A whole configuration is compact and realizes the information processor which can be integrated. This invention moreover, in the electrical circuit loop formation which consists of said probe and said record medium, and said electrical-potential-difference impression means Current-limiting electric resistance is established. It is a larger value than the 1st threshold of the electric resistance which restricts a current to the 1st current threshold corresponding to the threshold to which either of said probes and said record media carries out thermal destruction of the current-limiting electric resistance with the heat generated according to the current which flows between said probes and said record media by said electrical-potential-difference impression. It considers as the range of a value smaller than the 2nd threshold of the electric resistance which restricts a current to the 2nd current threshold corresponding to the threshold which said record medium softens with said heat, and thermal destruction of said account probe and said record medium can be prevented. And said record pit means forming is more effective if the electrostatic force which adds to this repulsive force as force which pushes in the tip of the probe supported with the elastic body to the record medium, using the repulsive force which acts between this probe and this record medium, and acts between this probe and this record medium by electrical-potential-difference impression is used. Moreover, the information processor of this invention can constitute an AFM regenerative apparatus from an elastic deformation detecting signal outputted from a means to detect the elastic deformation of said elastic body, and this elastic deformation detection means with the signal-processing means for the information playback which detects the record bit of the concave structure formed on said record medium. Furthermore, the information processor of this invention can constitute a catalytic-current regenerative apparatus from a current detecting signal outputted from a current detection means to detect the current which flows between said probes and said record media by electrical-potential-difference impression of said electrical-potential-difference impression means, and this current detection means with the signal-processing means for the information playback which detects the record bit of the concave structure formed on said record medium. By making it move in the direction which leaves the tip and said record medium of said probe to said record medium softened with the heat generated according to the current which flows by electrical-potential-difference impression by said electrical-potential-difference impression means, the record bit elimination means in the information processor of this invention can be constituted so that said concave structure record bit may be eliminated. Moreover, the configuration which the temperature of this whole record medium is raised with a heating means to raise the temperature of said record medium, as the - ****** means, and carries out record BITTO ****** can be taken, and the configuration which the temperature of this exposure part on this record medium is alternatively raised by the beam exposure of the source of a beam, and eliminates a bit alternatively as a block elimination means can be taken. In the information processing approach of the information processing approach of this invention scanning a probe to the record medium which counters this, and processing information by detecting the signal produced from the physical development As opposed to

the record medium softened in the temperature rise of the heat generated according to the current which flows among them by impression of the electrical potential difference of a between [said probes and said record media] It is characterized by making the force which pushes in the tip of the probe supported with the elastic body act, and forming the record bit of concave structure in this record-medium front face. This approach restricts the current which flows between this record medium and this probe in impression of that electrical potential difference. The tip of the probe which could constitute so that thermal destruction of said account probe and said record medium might be prevented, and was supported [bit / the / record] with the elastic body in formation is contacted to extent to which repulsive force acts on said record-medium front face. According to this repulsive force Or by adding the electrostatic force which acts between this record medium and this probe by electrical-potential-difference impression to this repulsive force, it can be made to be able to act so that the tip of the probe supported with said elastic body to this record medium may be pushed in, and it can constitute so that a record bit may be formed.

[0006]

[Function] This invention forms the record bit of concave structure by contacting a probe tip to a recording layer front face using what is thermally softened as a recording layer, as described above, carrying out heat softening of the recording layer with the heat generated by electrical-potential-difference impression, and pushing in a probe tip into a recording layer according to the force committed between recording layers. Therefore, optics, such as the light source for irradiating light at a record part like before, a mirror, and a lens, do not need to become unnecessary, and it is not necessary to irradiate a focusing light beam apart from AFM signal detection in the location at the tip of an AFM probe for record, and the time and effort of equipment adjustments, such as alignment, is mitigated.

[0007]

[Example] Hereafter, the example of this invention is explained based on a drawing.

[Example 1] drawing 1 is drawing showing the configuration of the information record regenerative apparatus of the example 1 of this invention. The xyz drive 103 is driven and at least predetermined one which performs record on record-medium 104 front face makes the tip of a probe 105 approach ** based on the signal from the xyz drive circuit 102 by control of a host computer 101 in drawing 1 . Here, similarly, in response to control of a host computer 101, a record pulse voltage is impressed to the pulse voltage source 108 for a record control signal between a probe 105 and a record medium 104 according to delivery and the pulse voltage source 108 from record/elimination control circuit 107, a record bit is formed on a record medium 104, and information is recorded. The probe 105 is supported by the lever 106 which consists of an elastic body, and probe 105 tip touches extent on which about [10-7-10-9N] repulsive force acts to record-medium 104 front face. In the case of the scan of the probe 105 to the record medium 104 at the time of record playback, it is scanned so that a probe 105 may learn by the elastic deformation of a lever 106 in accordance with the wave of record-medium 104 front face, or the configuration of a record bit. Since a probe is in the condition of having always contacted the recording layer, it is difficult to adjust spacing of a probe and a substrate and to adjust a current value. Then, in order to adjust so that the current value which flows between a probe 105 and a record medium 104 at the time of record may become the suitable range, the current-limiting electric resistance 109 is inserted into the electrical circuit loop formation which consists of a probe 105-record-medium 104-pulse voltage source 108 as shown in drawing.

[0008] Below, drawing 2 is used and the detail of the record approach of this invention is explained. As shown in drawing 2 , the record medium 201 consists of what formed the recording layer 203 on the substrate 202 which has conductivity. As a recording layer 203, an ingredient which is softened is chosen by the temperature rise. As an example, thermoplastics, such as a polymethyl methacrylate (softening temperature -100 degree C) and polystyrene (** -100 degree C), is raised. Record layer thickness specifically has the desirable thickness of 10nm or less in the thickness which is extent to which a current flows enough in the case of the electrical-potential-difference impression not more than about 10V. Although a current flows by making an electrical potential difference higher than 10V even in thickness 10nm or more, since possibility that a probe and a substrate will break by electric field etc.

arises, also as for applied voltage, less than [10V] is desirable. What is necessary is just to use a metal and semiconductor materials, such as the conductive ingredient which has the melting point of 1000 degrees C or more which does not receive thermal destruction by about several 100-degree C temperature rise at the time of record as a probe 204 and a substrate 202, for example, Au, Pt, Ir, W, and Si, and GaAs. Now, to recording layer 203 front face, probe 204 tip is contacted, record pulse-voltage impression is performed, and a current is passed between a probe 204 and a substrate 203. With the heat generated according to this current, the temperature of a recording layer 203 is raised locally and a recording layer 203 is softened locally. Then, the tip of a probe 204 is pushed in into a recording layer 203 by the repulsive force committed between recording layers 203, and forms the concave structure 205 according to it. Here, the record bit 205 which the temperature of a recording layer 203 descends and has the formed concave structure is saved by stopping finishing electrical-potential-difference impression and passing a current at stability. In addition, during actual electrical-potential-difference impression, electrostatic force is also produced between a probe 204 and a substrate 203, this force is added to the repulsive force committed between a probe 204 and a recording layer 203, the force which pushes in the tip of a probe 204 into a recording layer 203 is increased, and it has the effectiveness which makes record bit formation more reliable.

[0009] How to choose the magnitude of the current-limiting electric resistance for adjusting the magnitude of the current passed between probe-recording layers here at the time of record is as follows. It is made for a recording layer ingredient to become temperature higher than the temperature softened thermally by the temperature rise by the heat generated in case a current flows. However, if temperature becomes high not much, a recording layer, a probe, and a substrate ingredient will produce carbonization, thermofusion, evaporation, etc., and will produce thermal destruction. Therefore, it is necessary to make it the temperature rise of a recording layer become smaller than the temperature which produces such a thermal runaway. For example, Au is chosen as a polymethyl methacrylate (PMMA) and a substrate ingredient as Pt and a recording layer ingredient as a probe ingredient. The flowing current is set to 50microA when a current-limiting electric resistance value will not put in 0 ohm, i.e., resistance, if the electric resistance between probe-substrates sets to 100kohm when the electrical potential difference impressed at the time of record is 5V. The heat generated in a recording layer is set to 250 microwatts per unit time amount according to this current. Even if it takes heat conduction into consideration, the temperature rise by this heat will become 1000 degrees C or more, and a probe tip, a recording layer, and a substrate will receive thermal destruction. Here, if a current-limiting electric resistance value is set to 5 M omega, the flowing current will serve as lmuA and generating heat will be set to 5 microwatts per unit time amount. The temperature rise by this heat is about 200 degrees C, and neither a probe nor a recording layer nor a substrate receives thermal destruction. Since the heat softening temperature of PMMA is about 100 degrees C, it softens with this generating heat and it forms concave structure in response to the force from a probe tip. In the condition that a current does not flow, since temperature has fallen at 100 degrees C or less, the formed structure is saved at stability. If it increases, for example, a current-limiting electric resistance value is furthermore set to 100 M omega, the flowing current will serve as 50nA(s) and generating heat will serve as 250nW (s) per unit time amount. The temperature rise by this heat is 100 degrees C or less, and is lower than the heat softening temperature of PMMA, and with this generating heat, since it does not soften, concave structure is not formed. As mentioned above, probe :P t, recording layer :P MMA, substrate:Au, and in the case of applied-voltage:5V, the value of the optimal current-limiting electric resistance for the recording method of this invention becomes for 1-10 M omega. In addition, above, although the PMMA recording layer on Au substrate was mentioned as the example and explained as a record medium, if conductive ingredients, such as PDA (poly diacetylene), are chosen as others, a conductive substrate becomes unnecessary and a PDA film can be independently used as a record medium which served both as the recording layer and the substrate.

[0010] The information playback from the record medium which performed information record as mentioned above is explained. In drawing 1 , information is reproduced by driving the xyz drive 103 like the time of record, scanning a probe 105 to a record medium 104, and detecting a record bit. There

is the playback approach performed [1st] by applying the principle of AFM as the detection approach of this record bit. This detects the deflection of the lever 106 produced according to the force of acting between a probe 105 and a record medium 104. using for example, an optical-lever method as an approach of detecting the amount of deflections of a lever -- coming out -- last ** If the light beam from laser 112 is irradiated at a lever 106 and change arises in the amount of deflections of a lever 106, change will be produced in whenever [angle-of-reflection / of the light by the lever 106]. 2 division sensor 113 detects change whenever [angle-of-reflection / of the reflected light]. As shown in drawing 2 , since the amount of lever deflections decreases, reduction of this amount of lever deflections is detected in the amount detector 110 of lever deflections, this detecting signal is processed in the regenerative-signal processing circuit 111, and it carries out to a record bit detecting signal, i.e., a regenerative signal, and inputs into a host computer 101 in the location of the record bit which has concave structure on a record medium 104.

[0011] The example 2 of [example 2] this invention is shown in drawing 3 . This as shown in this drawing by the source 301 of bias voltage Impress bias voltage between the probe 303-record media 304, and the catalytic current which flows between the probe 303-record media 304 is detected. It is constituted so that a record bit may be detected, and about the configuration and function of the other configurations 306, i.e., a lever, record/elimination control circuit 307, the pulse voltage source 308, the current-limiting resistance 309, the xyz drive circuit 310, and the xyz drive 311, it is the same as that of drawing 1 . The playback approach in this example is performed by detecting that catalytic current. In the part of the record bit on a record medium, as shown in drawing 4 , since concave structure is formed in a recording layer, compared with a record bit agenesis part, spacing of a probe tip and a substrate becomes small and the catalytic current increases. Increase of this catalytic current is detected in the current detector 302, this detecting signal is processed in the regenerative-signal processing circuit 305, and it carries out to a record bit detecting signal, i.e., a regenerative signal, and inputs into a host computer 306. the case of this playback approach -- a lever -- a variation rate -- it has the effectiveness that the optical system for detection also becomes unnecessary and equipment becomes still compacter.

[0012] Elimination of a record bit is performed by pulling up a probe, where heat softening of a sink and the recording layer is carried out for a current like the time of record. Probe 105 tip is made to specifically approach the record bit formation part on a record medium 104 using the configuration of drawing 1 (or drawing 3). From record/elimination control circuit 107, where an elimination control signal is impressed to the pulse voltage source 108 between a probe 105 and a record medium 104 according to delivery and the pulse voltage source 108, an elimination pulse voltage Furthermore, the xyz drive 103 is driven from record/elimination control circuit 107 in the direction which keeps away delivery and a record medium 104 for an elimination control signal from a probe 105 in the xyz drive circuit 102. Consequently, as shown in drawing 5 , the recording layer of the record bit formation part 501 softens thermally, in the condition of having adhered at probe 502 tip, it can pull up in the direction which separates from a substrate 503, and return and elimination are carried out for concave structure to flush structure. Here, by stopping finishing electrical-potential-difference impression and passing a current, the temperature of a recording layer 504 descends and flush structure is saved at stability. Moreover, the whole record medium is heated, the temperature of the whole is raised, using a heater etc. as an approach of eliminating collectively the record bit formed on the record medium, and you may make it eliminate the record bit of concave structure in package. Furthermore, it is also possible to carry out block elimination by irradiating the light beam which converged to the predetermined field on a record medium, using the whole field as 1 block.

[0013]

[Effect of the Invention] What is thermally softened as a recording layer is used for this invention as mentioned above. Contact a probe tip to a recording layer front face, and heat softening of the recording layer is carried out with the heat generated by electrical-potential-difference impression. Since a probe tip is pushed in into a recording layer according to the force committed between recording layers and the record bit of concave structure is formed Optics, such as the light source for irradiating light at a record part, a mirror, and a lens, become unnecessary. The whole equipment configuration is compact and can

constitute the information processor which can be integrated. Moreover, it is not necessary to irradiate a focusing light beam in the location at the tip of an AFM probe for record, the time and effort of equipment adjustments, such as alignment, is mitigated apart from AFM signal detection, and easy-ization of actuation etc. can be attained.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the information processor of the example 1 in this invention.
[Drawing 2] It is the explanatory view of the playback approach of the example 1 in this invention.
[Drawing 3] It is the block diagram of the information processor of the example 2 in this invention.
[Drawing 4] It is the explanatory view of the playback approach of the example 2 in this invention.
[Drawing 5] It is the explanatory view of the elimination approach in this invention.
[Description of Notations]
101: Host computer
102: xyz drive circuit
103: xyz drive
104: Record medium
105: Probe
106: Lever
107: Record/elimination control circuit
108: Pulse voltage source
109: Current-limiting electric resistance
110: The amount detector of lever deflections
111: Regenerative-signal processing circuit
112: Laser
113:2 division sensor
201: Record medium
202: Substrate
203: Recording layer
204: Probe
205: The record bit which has concave structure
301: The source of bias voltage
302: Current detector
303: Probe
304: Record medium
305: Regenerative-signal processing circuit
306: Lever
307: Record/elimination control circuit
308: Pulse voltage source
309: Current-limiting electric resistance
310: xyz drive circuit
311: xyz drive
501: Record bit formation part
502: Probe

503: Substrate
504: Recording layer

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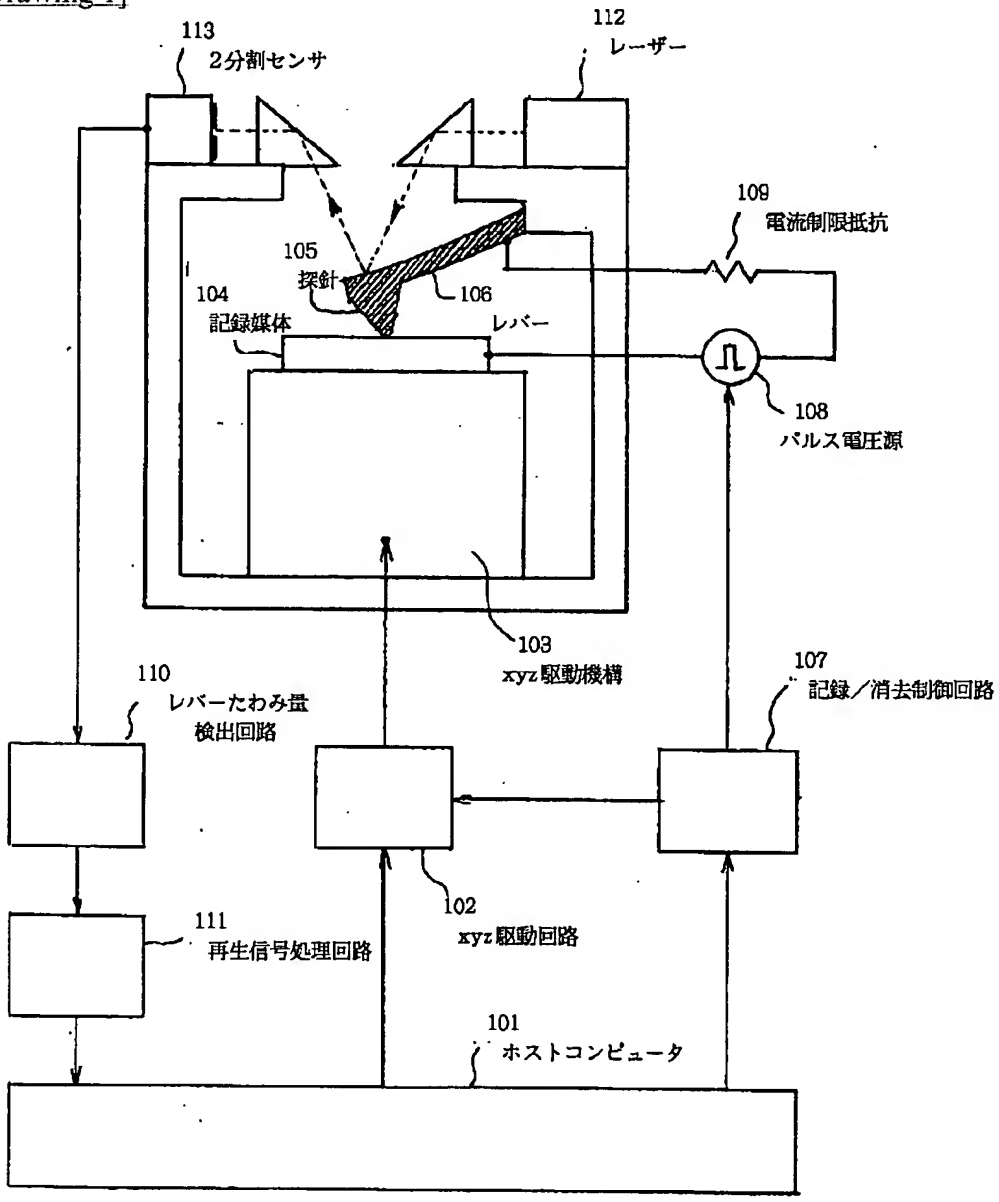
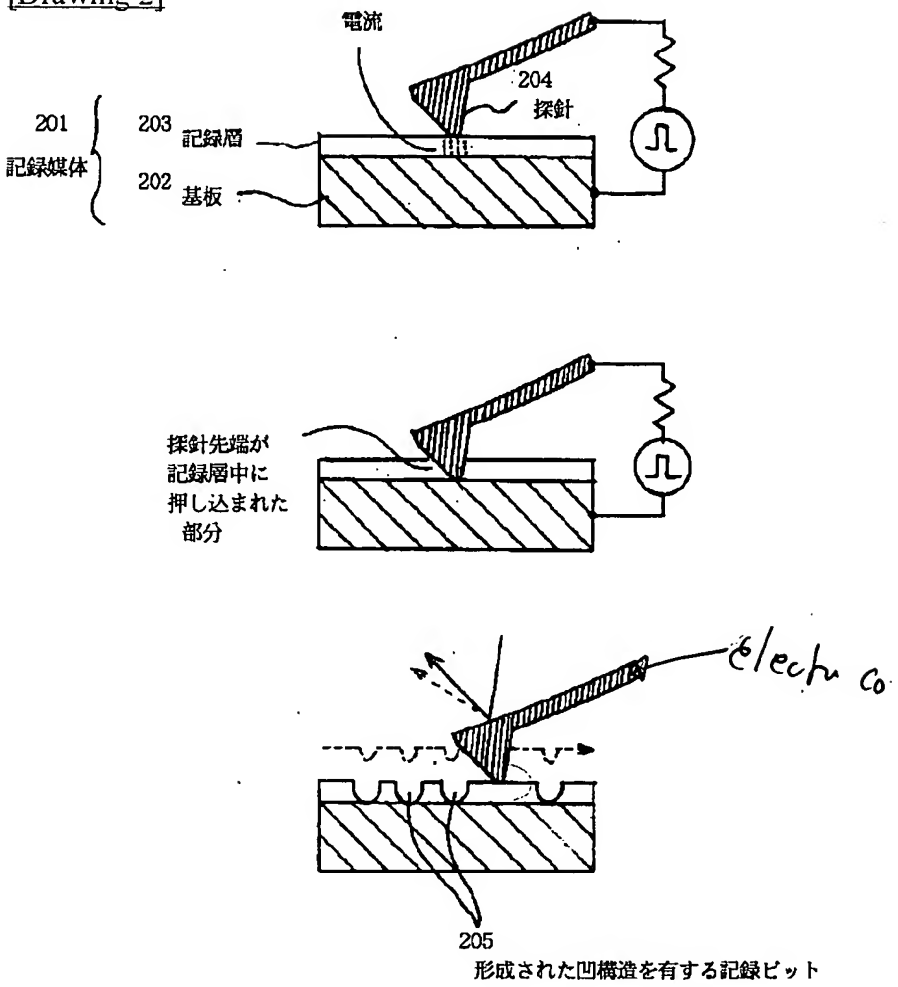
DRAWINGS

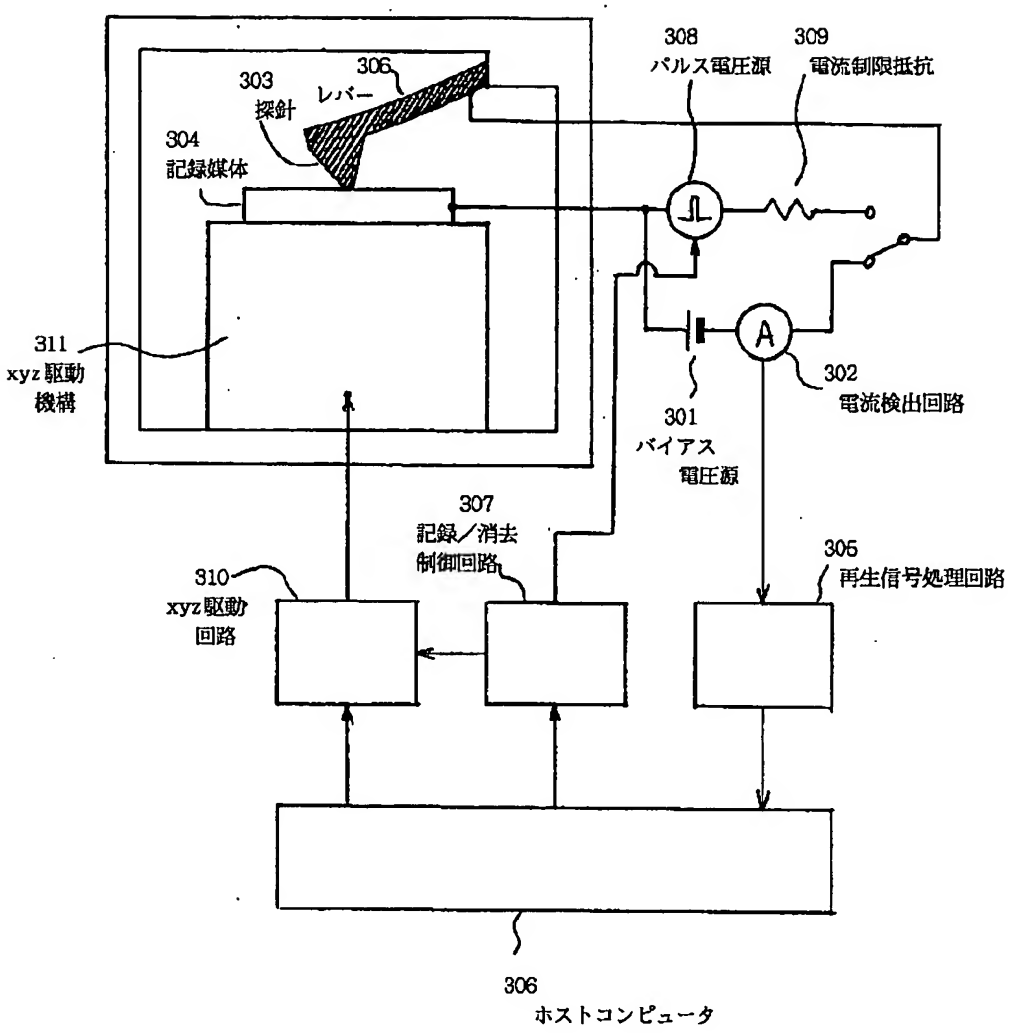
[Drawing 1]



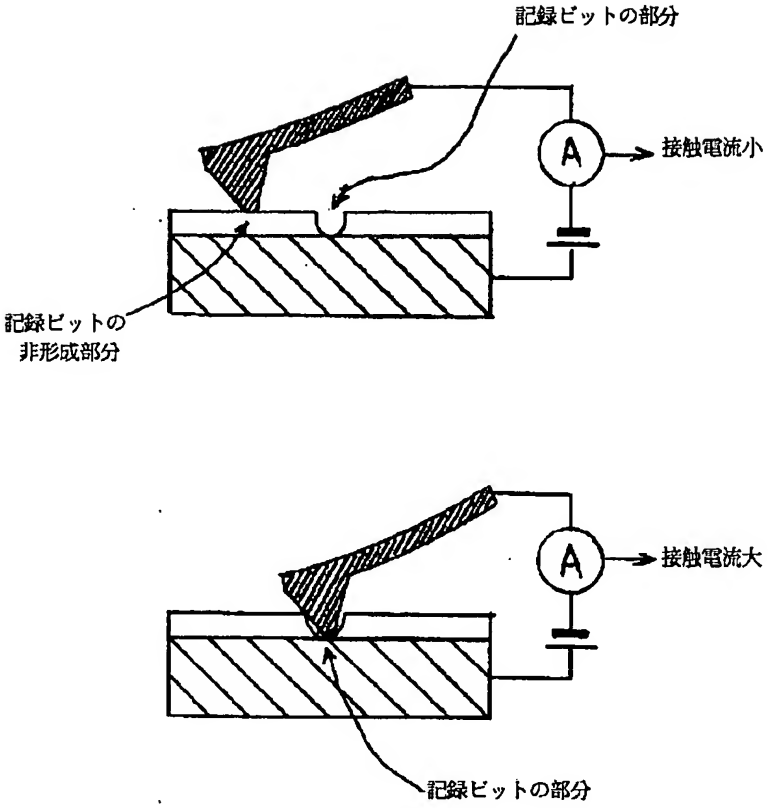
[Drawing 2]



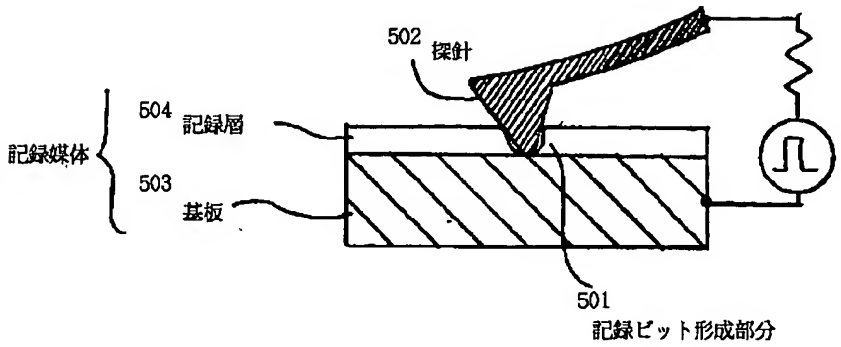
[Drawing 3]

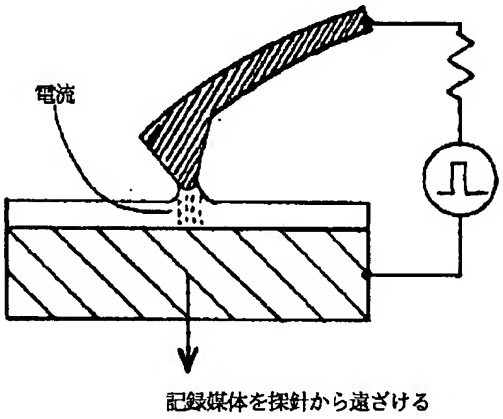

308
パルス電圧源
309
電流制限抵抗
306
303
探針
レバー
304
記録媒体
311
xyz駆動
機構
A
302
電流検出回路
301
バイアス
電圧源
307
記録／消去
制御回路
305
再生信号処理回路
310
xyz駆動
回路
306
ホストコンピュータ

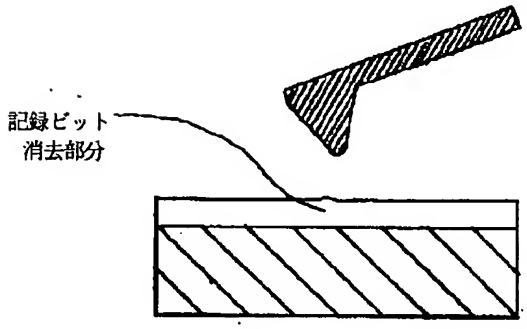
[Drawing 4]



[Drawing 5]







[Translation done.]